This section presents alternatives for the South Star Cogeneration Project (South Star Project). These include the "no project" alternative, alternative site locations for facilities, equipment configuration alternatives, alternative transmission routes, and alternative natural gas supply routes. The alternative site location analysis is applicable to each South Star site. Figure 2-1 provides the alternative site locations and alternative transmission routes discussed in this section. The goals of the South Star Project are to:

- Generate approximately 40,000 barrels per day of steam at South Star I to support TCI's existing and future South Midway Sunset Oilfield operations in Sections , 17 and 21, T32S, R23E
- Generate approximately 40,000 barrels per day of steam at South Star II to support TCI's existing and future South Midway Sunset Oilfield operations in Sections 7 and 8, T32S, R23E
- Match generation of electricity to TCI's planned cogeneration steam demand in the South Midway Oilfield;
- Utilize existing and planned TCI oilfield infrastructure; and
- Bring cost effective power generation online during the summer of 2002 and beyond.

5.1 NO PROJECT

Cogeneration, a proven and efficient dual energy production process, has become a leading technology in the independent generation of electric power. By producing two useful forms of energy — electricity and heat — from the combustion of a single fuel, cogeneration captures energy that might otherwise be wasted in conventional electrical and industrial processes.

In California's heavy oil producing regions, cogeneration processes prove especially beneficial. Cogeneration, in which both electrical and thermal energy are produced in the same cycle, is superior to production of electricity and steam in separate processes. The "no project" alternative would not allow for a more efficient use of resources for the production of both electricity and thermal energy. In addition, if the South Star Project were not built either:

1) Additional conventional steam generators would be constructed to meet future steam demand;
2) Another third party steam supplier with a comparable project configuration would be secured to meet future steam demand; or
3) Future oil production levels would be reduced due to the lack of available steam.

The Governor of the State of California issued recent Executive Orders to provide for emergency permit streamlining of projects that can help alleviate the current California energy crisis. Specifically, Executive Order D-26-01 directed the CEC to expedite processing of AFCs for projects such as the South Star Project, which can provide California with 100 MW of new generating capacity in 2002 and an additional 100 MW in 2003.

The "no project" alternative does not provide much needed new generating capacity.

5.2 ALTERNATIVE SITE LOCATIONS

South Star recognizes the advantages that affiliation with a thermal host offers generators in the merchant plant market. Because steam demand by the thermal host is typically continuous, a thermal host offers operating stability that reduces the risk of doing business in a deregulated market environment. Site locations for a cogeneration project, however, are limited to those in proximity to locations where steam is needed by the thermal host. Furthermore, it is recognized that proximity to natural gas supply, transmission interconnection, and other utilities lowers overall plant costs and results in fewer environmental impacts and a more economical project.

The following factors were considered in selection of each site for the project:

- For South Star I, proximity to existing and future area of steam demand in Sections 17 and 21, T32S, R23E;
- For South Star II, proximity to existing and future area of steam demand in Sections 7 and 8, T32S, R23E;
- Proximity to TCI South Midway Utility Corridor;
- Proximity to existing transmission lines;

- Proximity to main oilfield access roads;
- Avoidance of active oilfield operations; and
- Land ownership.

The following sections describe alternative sites considered for the South Star project.

5.2.1 South Star I

The South Star I site is located in the southeast quarter of Section 17, Township (T) 32 South (S), Range (R) 23 East (E). The property is currently owned by Texaco California Inc. (TCI) and will be leased to the South Star Project. The surrounding area is heavily developed for natural gas and oil production, and is utilized primarily by TCI and other petroleum companies. Active oil production and storage facilities, aboveground pipelines, steam generation facilities, electric transmission facilities, and access roads characterize the area.

The South Star I site is centrally located relative to the area of the TCI's South Midway Sunset Oilfield with the largest undeveloped oil reserves and therefore the greatest long term need for steam. The site is also adjacent to TCI's South Midway Utility Corridor. The site is located within 0.6 miles of TCI's existing transmission line and is accessible by an existing oilfield road. The above characteristics make the site ideally suited for the South Star I. This AFC demonstrates that there are no significant environmental impacts associated with this site.

5.2.2 South Star II

The South Star II site is located in the middle of Section 7, T32S, R23E, the property is currently owned by Texaco California Inc. (TCI) and will be leased to the South Star Project. South Star II is centrally located relative to the area of the TCI's South Midway Oilfield with the largest undeveloped oil reserves and therefore the greatest long term need for steam. This site is also directly adjacent to TCI's South Midway Utility Corridor and existing transmission line. It is directly accessible by an existing oilfield road. Furthermore,

there is no active oilfield operation on this site. The above features make the site ideally suited for South Star II. This AFC demonstrates that there are no significant environmental impacts associated with this site.

5.2.3 Existing South Midway Steam Plant

Although the South Midway Steam Plant is located in close proximity to oil production areas in Sections 7 and 8 and is adjacent to TCI's South Midway Utility Corridor and existing transmission line; it is in an area of congested oil field operations and offers no significant environmental benefit. In addition, construction of either or both South Star facilities at this site would interfere with active oil field operations, causing unfavorable economic impacts to TCI.

5.2.4 Existing Section 21 Steam Plant

The Section 21 Steam Plant is located in the northeast quarter of Section 21 and would require longer natural gas and transmission line interconnections as compared to any of the other locations described above. These longer interconnections make the Section 21 Steam Plant the least attractive alternative for either South Star location. The Section 21 Steam Plant is less centrally located relative to the oilfield than South Star I and would therefore result in less efficient distribution of steam to TCI. This alternative site provides no reduction of potential environmental effects relative to the South Star I site location. Due to the longer natural gas and transmission line interconnections, this location would have a greater potential for adverse environmental effects and be more expensive to build.

Based on the above analyses, the preferred site locations for South Star I and South Star II are the Section 17 and Section 7 sites, respectively.

5.3 ALTERNATIVE PROJECT CONFIGURATIONS

The selection of the project configuration for the South Star Project was based on consideration of the following factors:

- Commercially available turbine types to meet the project schedule;

- Number of units required to meet the desired electrical and steam output;
- Project economics; and
- Ability of the emissions control equipment to meet the air quality regulations.

The proposed South Star Project configuration will generate at each site approximately 100 megawatts (MW) of electrical output for sale and approximately 40,000 barrels per day of 65-80% quality steam to be provided to TCI for use in EOR operations. Each project will consist of four Rolls Royce RB211 CTGs, each exhausting into a dedicated heat recovery steam generator (HRSG). The HRSGs are unfired "once-through", drumless-type steam generators designed to capture exhaust heat from the CTGs to produce steam. Both CTGs and HRSGs are commercially available technologies and have been widely used in cogeneration applications.

5.3.1 Combustion Turbine Generators

The basic project configuration was selected based on the availability of CTGs within the timeframe required to meet the project schedule and California's need for power in 2002. Although other CTGs were considered in addition to the Rolls Royce RB211, none provided improved delivery dates or better overall project economics.

Alternative combustion turbine generators considered for the project included General Electric (GE) Frame 7FA, GE LM2500, GE LM6000, Pratt and Whitney FT8T Twin Pac, and GE Frame 5. Several of these alternatives could not provide guaranteed equipment availability to meet the project size and/or schedule, thus creating significant risk to the project. All other alternatives had a limited number of units available and precluded the ability to develop a standardized design. This created further risk of either finding additional units or developing a more complex, non-standard design in the limited time available. Several alternatives required upfront, and in some cases, non-refundable payments that adversely affected overall project economics.

Rolls Royce was the only manufacturer that offered the number of units required to meet the schedule for generating 100 MW in summer 2002 and beyond. Rolls Royce also offered economic incentives that could be applied to project development costs. Rolls

Royce's ability to supply equipment to meet the project schedule and their superior economics clearly indicated that they are the preferred CTG alternative.

5.3.2 Heat Recovery Steam Generators

The HRSG captures the exhaust heat from each CTG to produce high-pressure steam for the EOR process. These units are once through, drumless type steam generators. Each HRSG is equipped with a feedwater preheat section (economizer) and an evaporator section designed to generate 65% to 80% quality steam. These sections are designed with multiple sets of parallel, horizontal, carbon steel tubes in the path of the horizontal gas flow. The HRSG control system maintains 65 to 80% quality at the steam outlet. Since there is no blowdown, this leaves 20 to 35% water as the medium for carrying through the total dissolved solids that remain in the feedwater. The HRSG design pressure is 1,500 psig and the normal operating pressure is 1,250 psig. There is an estimated 50 pounds per square inch (psi) pressure drop in the steam piping to the EOR operation.

An alternative to conventional unfired HRSG technology is an HRSG equipped with duct firing. With duct firing, fuel is combusted in a duct burner located in the HRSG. This alternative would increase the amount of steam that can be produced. The major disadvantages of duct firing, however, are increased air emissions, introduction of design and operating complexity, and increased fuel use. There is limited experience with duct firing in a once-through HRSG of the proposed size. In addition, the projected steam demands for the TCI EOR operations can be generated by conventional HRSGs without duct firing. Accordingly, HRSGs with duct firing were not considered further.

5.3.3 Alternate Fuels

Natural gas is the preferred fuel for the South Star Project. Natural gas supply to the project site is considered to be very reliable. Natural gas combustion also results in minimal air emissions.

Possible alternative fuels for the project include distillate oil, crude oil, produced gas, petroleum coke, and biomass. Each of these alternate fuels is less favorable because they

would produce greater air quality impacts than the preferred fuel. Distillate oil would require construction of a new pipeline or truck transportation. Petroleum coke and biomass would need to be transported to the site by truck, resulting in additional transportation-related environmental impacts. A gasifier would be required to use petroleum coke, crude oil, or biomass as a turbine fuel, adding additional cost, environmental impacts, and operational complexity.

For these reasons, natural gas has been selected as the sole fuel for the South Star Project.

5.3.4 Alternative Cycles

In addition to cogeneration cycles, CTGs can also be utilized to produce power in both simple cycle and combined cycle configurations. A simple cycle configuration involves use of CTGs but does not utilize an HRSG to produce steam. Therefore, in a simple cycle configuration, the hot exhaust gases of the CTG are discharged to atmosphere and the energy in this stream is wasted. The simple cycle alternative would eliminate a needed source of steam for TCI's oilfield operation. This would require TCI to operate additional steam generators to meet their steam demand and would fail to meet an objective of the project. The simple cycle alternative would result in an inefficient use of resources as well as a less economical project.

In a combined cycle configuration, the steam produced in the HRSG is used to generate additional power in a steam turbine. A combined cycle configuration would involve the addition of an HRSG, most likely with supplemental firing, a steam turbine, a condenser, and a cooling tower. The steam cycle would be configured to extract the quantity of steam required by the thermal host. The combined cycle configuration would provide for potentially greater electrical power output than the current configuration. However, this configuration would result in greater environmental impacts since it would require a substantial quantity of cooling water, would produce a large wastewater discharge stream and would involve the potential for visible plumes associated with wet cooling tower operation.

A principal advantage of the cogeneration cycle with a once-through HRSG is that the cycle can utilize produced water from oilfield operations. The water is recovered with the oil, separated, treated (softened) and reused in the cycle. Because of its source, the water typically contains high levels of dissolved solids and other contaminants. If this water were to be used in a combined cycle process, water treatment costs would be significant since the combined cycle process requires water of sufficient quality to produce superheated steam for use in a steam turbine.

The cogeneration cycle with a once-through HRSG, on the other hand, can utilize the oilfield-produced water with minimum treatment required. Steam is produced at 65-80% quality (saturated) that prevents deposits or scaling in the HRSG tubes. Therefore, the preferred alternative avoids some of the negative environmental impacts of a combined cycle process.

5.3.5 Preferred Project Configuration

The preferred configuration for the South Star Project consists of four gas-fired Roll-Royce RB 211 CTGs at each site equipped with dry low NO_x combustor technology and four HRSGs with aqueous ammonia type selective catalytic reduction (SCR). The preferred configuration was selected because:

- The CTGs and HRSGs are commercially available units that will efficiently meet the desired electrical and steam outputs;
- The emissions control devices will meet all applicable air quality regulations; and
- Four cogeneration trains at each site are the most economically viable alternative with the lowest capital cost to meet the steam demand.

5.4 ALTERNATIVE TRANSMISSION ROUTES

The selection of the transmission line route and substation location included consideration of:

- Potential environmental impacts of the transmission line between the South Star Project sites and the point of interconnection;

- The ability to acquire control of substation site land and obtain rights-of-way required for the line; and
- Potential engineering constraints.

The magnitude of transmission line impacts is directly related to the width of the right-of-way, height of structures, and the length and location of the transmission line route. Most environmental impacts due to transmission line development occur during construction when support structures are put in place, access trails and staging areas are developed, and rights-of-way are cleared. The impacts can include fugitive dust and vehicle/equipment exhaust emissions due to construction activities; wildlife disturbance due to noise and human activity; removal and in some cases replacement of native vegetation; disturbance of historic or archaeological features; and erosion due to stormwater runoff. Negative impacts during operation may include bird mortality from electrocution and collisions with power lines and visual impacts of the transmission line facilities. The potential effects of long term exposure to electromagnetic fields, particularly on human health may also need to be considered.

Transmission facilities considered for connecting the South Star Project to the existing transmission grid for California include:

- One switchyard adjacent to the preferred locations of South Star I and South Star II; and
- An existing direct transmission line route to connect the South Star facilities to the existing TCI Morgan Substation and 115kV Pacific Gas & Electric (PG&E) transmission line.

The preferred route involves reconductoring an existing transmission line and adding 0.6 miles of new transmission line from the South Star I switchyard interconnecting at the existing TCI Morgan Substation to the PG&E system. A second circuit would be installed on that same existing transmission line from South Start II to the TCI Morgan Substation. Alternatively, South Star II would install a new transmission line parallel to the existing transmission line to Morgan Substation. Land use along the preferred route is a combination of active oil production and storage facilities, electric transmission facilities, and native terrestrial vegetation

Figure 2-1 shows the location of the preferred route and the alternative parallel route for South Star II.

The preferred route is an existing TCI transmission corridor and is the shortest length between the South Star Project and Morgan Substation. The route is approximately 5.3 miles from South Star I and 3.8 miles from South Star II to Morgan Substation. Based on its existing direct configuration, the preferred route would be expected to have the lowest cost and the least overall potential for impacting environmental resources. In addition, there were no issues that cannot be mitigated along the preferred route.

Suitability for interconnection to the existing transmission grid was also a consideration. The preferred route connects to PG&E's system at the existing Morgan Substation and a minimal amount of system upgrades/modifications would be required at this location.

No other transmission alternatives were evaluated because they would involve longer routes, with correspondingly greater environmental impacts and potentially significant transmission upgrades, and/or they would require rights-of-way through intensively developed oilfield areas where avoiding interference with existing oil production activities is a significant impact to TCI's operations.

Morgan Substation Site. The Morgan Substation is owned by TCI and is the closest substation to the South Star sites. Therefore, it is the primary substation that was given serious consideration. The Morgan Substation is tied to the PG&E 115 kV transmission line. This site minimizes the length of the transmission loop-in lines that will be required for the interconnection.

Additional discussion of the transmission route can be found in Section 6.3, Transmission System Evaluation.

5.5 ALTERNATIVE NATURAL GAS SUPPLY

Natural gas requirements for the CTGs at each site are approximately 27,000 MMBtu (LHV) per day for the cogeneration operation to meet the proposed 100 MW electrical output and steam production of approximately 40,000 barrels per day. The performance of combustion turbines varies in relation to ambient temperature. Fuel consumption will be highest at low ambient temperatures.

Natural gas will be supplied to the South Star Project from the Kern River Gas Transmission Company and Mojave Pipeline Company (Kern-Mojave) via a new interconnecting pipeline to be constructed by South Star. An approximately 3.6 mile pipeline will extend from the South Star I to the planned gas metering station at the Kern-Mojave interconnection. Approximately 1.25 miles of the pipeline would be placed on aboveground pipe supports in the TCI South Midway Utility Corridor from South Star I to the Station 109 Gas Dehydration Plant, before proceeding underground to the Kern-Mojave interconnection. An approximately 1.4 mile pipeline will extend from South Star I to South Star II.

Two alternative gas supply routes have been identified. Alternative 1 follows a slightly longer route from the Kern-Mojave pipeline to Station 109. This option uses existing TCI-owned land or rights-of-way but would require slightly greater land disturbance and cost. Alternative 2 would require a 1.5 mile interconnection to the TCI South Midway Utility Corridor at South Star II from the southern terminus of the existing TCI utility corridor. This alternative, while shorter, would need to traverse undulating terrain would need to traverse active oilfield areas and would be more expensive to build. The preferred route was chosen because it has the least cost, and environmental impacts on this route are not significant.

The supply from the Kern/Mojave system is abundant and reliable, and no alternate gas supply is being incorporated into the facility design. In addition, the facility is being designed to operate exclusively on natural gas. In the unlikely event of an interruption in the Kern/Mojave gas supply either for operational or physical reasons; the South Star Project would shut down until the fuel supply system was restored.